CLAIMS

1. A system for developing a database of body surface ECG P wave data for classification and localization of left atrial arrhythmias wherein said database is derived from P wave data of two or more subjects comprising:

   (a) means for receiving said P wave data from a subject;

   (b) means for classifying said P wave data and thereby creating classified P wave data;

   (c) means for averaging said classified P wave data and thereby creating mean P wave data; and

   (d) means for storing and accessing said mean P wave data in said database.

2. The system as set forth in claim 1, wherein one of said left atrial arrhythmias is an atrial tachycardia, a focal atrial fibrillation, or an orthodromic AV reentrant tachycardia involving an accessory pathway.

3. The system as set forth in claim 1, wherein said P wave data is in the form of maps.

4. The system as set forth in claim 3, wherein said maps are in the form of integral maps.

5. The system as set forth in claim 3, wherein said maps are in the form of potential maps.

6. The system as set forth in claim 1, further comprises means for obtaining said P wave data by electrically stimulating a left atrium of said subject using a probe.

7. The system as set forth in claim 6, wherein said P wave data is obtained using a transseptal procedure.

8. The system as set forth in claim 6, wherein said P wave data is obtained using a retrograde aortic procedure.

9. The system as set forth in claim 1, further comprises means for obtaining said P wave data from spontaneously occurring left atrial arrhythmias.

10. The system as set forth in claim 1, further comprises means for obtaining said P wave data by inducing left atrial arrhythmias.

11. The system as set forth in claim 1, wherein said receiving means further comprises means for sensing heart cycle signals while said subject is spontaneously producing a left atrial arrhythmia, while a left atrial arrhythmia is induced in said subject, or while a left atrial pacing is being performed in said subject.

12. The system as set forth in claim 11, wherein said receiving means further comprises means for detecting an electrical heart signal with a plurality of sensors proximate a subject's torso.

13. The system as set forth in claim 12, wherein said receiving means further comprises means for separating from said electrical heart signal an atrial signal obscured by a ventricular signal.

14. The system as set forth in claim 12, wherein said receiving means further comprises means for selecting at least one reference cycle from among a plurality of heart cycles to determine said P wave data.

15. The system as set forth in claim 14, wherein said receiving means further comprises means for selecting a time interval of said reference cycle and comparing signals from said plurality of sensors during said selected time interval.

16. The system as set forth in claim 15, wherein said receiving means further comprises means for generating a data matrix by integrating said signals from each sensor location within said selected time interval to define an integral value, and arranging said integral value within said matrix according to locations of said associated sensor locations along a surface of said subject's torso.

17. The system as set forth in claim 16, wherein said receiving means further comprises means for computing an integral map over said selected time interval and plotting said data matrix.

18. The system as set forth in claim 17, wherein said computing means further comprises means for determining lines of constant integral values, and identifying maps of said P wave data using said lines of constant integral values mapped upon representations of said surface of said subject's torso.

19. The system as set forth in claim 17, wherein said computing means further comprises means for representing different integral values by one or more different colors mapped upon representations of said surface of said subject's torso.

20. The system set forth in claim 15, wherein said receiving means further comprises means for generating a data matrix of potential signals from each sensor location within said selected time interval to define one or more potential values, and arranging said potential values within said matrix according to locations of said associated sensor locations along said surface of a subject's torso.

21. The system set forth in claim 20, wherein said receiving means further comprises means for computing one or more potential maps over said selected time interval and plotting said data matrix.

22. The system as set forth in claim 21, wherein said computing means further comprises means for determining lines of constant potential values, and identifying maps of said P wave data using said lines of constant potential values mapped upon representations of said surface of said subject's torso.

23. The system as set forth in claim 21, wherein said computing means further comprises means for representing different potential values by one or more different colors mapped upon representations of said surface of said subject's torso.

24. The system as set forth in claim 1, wherein said classifying means further comprises means for determining one or more groups of said P wave data with nearly identical P wave morphology.

25. The system as set forth in claim 24, wherein said determining means uses a statistical analysis for determining said one or more groups of said P wave data with nearly identical P wave morphology.

26. The system as set forth in claim 24, wherein said determining means uses pattern recognition techniques for determining said one or more groups of said P wave data with nearly identical P wave morphology.

27. The system as set forth in claim 24, wherein said determining means uses neural networks for determining said one or more groups of said P wave data with nearly identical P wave morphology.

28. The system as set forth in claim 24, wherein said determining means uses anatomical subdivisions of a heart for determining locations of left atrial ectopic origins.

29. The system as set forth in claim 1, wherein said classifying means further comprises verifying means to verify said P wave data.

30. The system as set forth in claim 29, wherein said verifying means uses statistical analysis techniques to verify said P wave data.

31. The system as set forth in claim 29, wherein said verifying means further comprises means for computing correlation coefficients between said P wave data.

32. The system as set forth in claim 31, wherein said means for computing correlation coefficients further comprises means for assessing intragroup pattern uniformity.

33. The system as set forth in claim 31, wherein said means for computing correlation coefficients further comprises means for assessing intergroup pattern variability.

34. The system as set forth in claim 29, wherein said averaging means further comprises means for calculating mean P wave data from said verified P wave data to construct a database of verified mean P wave data.

35. The system as set forth in claim 1, wherein said averaging means further comprises means for associating said mean P wave data to an ectopic origin in a heart wherein said P wave data is obtained during left atrial pacing or spontaneously occurring or induced left atrial arrhythmias.

36. The system as set forth in claim 35, wherein said associating means uses a schematic diagram of a left atrium.

37. The system as set forth in claim 35, wherein said associating means uses an anatomical diagram of a left atrium.

38. The system as set forth in claim 35, wherein said associating means uses biplane fluoroscopic views of said heart.

39. The system as set forth in claim 1, wherein said storing means further comprises means for using a computer to store, search and analyze said mean P wave data.

40. The system as set forth in claim 39, wherein said storing means further comprises means for using said computer to classify and localize said left atrial arrhythmias.

41. A method for developing a database of body surface ECG P wave data for classification and localization of left atrial arrhythmias wherein said database is derived from P wave data of two or more subjects comprising the steps of:

(a) receiving said P wave data from a subject;

(b) classifying said P wave data into classified P wave data;

(c) averaging said classified P wave data into mean P wave data; and

(d) storing and accessing said mean P wave data in said database.

42. The method as set forth in claim 41, wherein one of said left atrial arrhythmias is an atrial tachycardia, a focal atrial fibrillation, or an orthodromic AV reentrant tachycardia involving an accessory pathway.

43. The method as set forth in claim 41, wherein said P wave data is in the form of maps.

44. The method as set forth in claim 43, wherein said maps are in the form of integral maps.

45. The method as set forth in claim 43, wherein said maps are in the form of potential maps.

46. The method as set forth in claim 41, further comprises the step of obtaining said P wave data by electrically stimulating a left atrium of said subject using a probe.

47. The method as set forth in claim 46, wherein said P wave data is obtained using a transseptal procedure.

48. The method as set forth in claim 46, wherein said P wave data is obtained using a retrograde aortic procedure.

49. The method as set forth in claim 41, further comprises the step of obtaining said P wave data from spontaneously occurring left atrial arrhythmias.

50. The method as set forth in claim 41, further comprises the step of obtaining said P wave data by inducing left atrial arrhythmias.

51. The method as set forth in claim 41, wherein said step of receiving further comprises the step of sensing heart cycle signals while said subject is spontaneously producing a left atrial arrhythmia, while a left atrial arrhythmia is induced in said subject, or while a left atrial pacing is being performed in said subject.

52. The method as set forth in claim 51, wherein said step of receiving further comprises the step of detecting an electrical heart signal with a plurality of sensors proximate a subject's torso.

53. The method as set forth in claim 52, wherein said step of receiving further comprises the step of separating from said electrical heart signal an atrial signal obscured by a ventricular signal.

54. The method as set forth in claim 52, wherein said step of receiving further comprises the step of selecting at least one reference cycle from among a plurality of heart cycles to determine said P wave data.

55. The method as set forth in claim 54, wherein said step of receiving further comprises the step of selecting a time interval of said reference cycle and comparing signals from said plurality of sensors during said selected time interval.

56. The method as set forth in claim 55, wherein said step of receiving further comprises the step of generating a data matrix by integrating said signals from each sensor location within said selected time interval to define an integral value, and arranging said integral value within said matrix according to locations of said associated sensor locations along a surface of said subject's torso.

57. The method as set forth in claim 56, wherein said step of receiving further comprises the step of computing an integral map over said selected time interval and plotting said data matrix.

58. The method as set forth in claim 57, wherein said step of computing further comprises the step of determining lines of constant integral values, and identifying maps of said P wave data using said lines of constant integral values mapped upon representations of said surface of said subject's torso.

59. The method as set forth in claim 57, wherein said step of computing further comprises the step of representing different integral values by one or more different colors mapped upon representations of said surface of said subject's torso.

60. The method set forth in claim 55, wherein said step of receiving further comprises the step of generating a data matrix of potential signals from each sensor location within said selected time interval to define one or more potential values, and arranging said potential values within said matrix according to locations of said associated sensor locations along said surface of a subject's torso.

61. The method set forth in claim 60, wherein said step of receiving further comprises the step of computing one

or more potential maps over said selected time interval and plotting said data matrix.

62. The method as set forth in claim 61, wherein said step of computing further comprises the step of determining lines of constant potential values, and identifying maps of said P wave data using said lines of constant potential values mapped upon representations of said surface of said subject's torso.

63. The method as set forth in claim 61, wherein said step of computing further comprises the step of representing different potential values by one or more different colors mapped upon representations of said surface of said subject's torso.

64. The method as set forth in claim 41, wherein said step of classifying further comprises the step of determining one or more groups of said P wave data with nearly identical P wave morphology.

65. The method as set forth in claim 64, wherein said step of determining further comprises the step of providing a statistical analysis for determining said one or more groups of said P wave data with nearly identical P wave morphology.

66. The method as set forth in claim 64, wherein said step of determining further comprises the step of providing pattern recognition techniques for determining said one or more groups of said P wave data with nearly identical P wave morphology.

67. The method as set forth in claim 64, wherein said step of determining further comprises the step of providing neural networks for determining said one or more groups of said P wave data with nearly identical P wave morphology.

68. The method as set forth in claim 64, wherein said step of determining further comprises the step of providing anatomical subdivisions of a heart for determining locations of left atrial ectopic origins.

69. The method as set forth in claim 41, wherein said step of classifying further comprises the step of verifying to verify said P wave data.

70. The method as set forth in claim 69, wherein said step of verifying further comprises the step of providing statistical analysis techniques to verify said P wave data.

71. The method as set forth in claim 69, wherein said step of verifying further comprises the step of computing correlation coefficients between said P wave data.

72. The method as set forth in claim 71, wherein said step of computing correlation coefficients further comprises the step of assessing intragroup pattern uniformity.

73. The method as set forth in claim 71, wherein said step of computing correlation coefficients further comprises the step of assessing intergroup pattern variability.

74. The system as set forth in claim 69, wherein said step of averaging further comprises the step of calculating mean P wave data from said verified P wave data to construct a database of verified mean P wave data.

75. The method as set forth in claim 41, wherein said step of averaging further comprises the step of associating said mean P wave data to an ectopic origin in a heart wherein said P wave data is obtained during left atrial pacing or spontaneously occurring or induced left atrial arrhythmias.

76. The method as set forth in claim 75, wherein said step of associating further comprises the step of using a schematic diagram of a left atrium.

77. The method as set forth in claim 75, wherein said step of associating further comprises the step of using an anatomical diagram of a left atrium.

78. The method as set forth in claim 75, wherein said step of associating further comprises the step of using biplane fluoroscopic views of said heart.

79. The method as set forth in claim 41, wherein said step of storing further comprises the step of using a computer to store, search and analyze said mean P wave data.

80. The method as set forth in claim 79, wherein said step of storing further comprises the step of using said computer to classify and localize said left atrial arrhythmias.

81. An apparatus for classification and localization of left atrial arrhythmias, comprising:

(a) a signal processor means for receiving electrical signals indicative of a heart's electrical activity from a plurality of torso sites during a left atrial arrhythmia;

(b) a means for receiving said P wave signals to compute one or more data maps of said P wave signals;

(c) a classifying means for classifying said data maps of said left atrial arrhythmia, wherein said data maps are classified based on a comparison of said data maps to a database of mean P wave data maps;

(d) a transformation means for graphically representing said data maps of said left atrial arrhythmia on a torso representation of a subject; and

(e) a localizing means for localizing an origin of said left atrial arrhythmia on a representation of a left atrium based on said classified data map.

82. The apparatus as set forth in claim 81, wherein said left atrial arrhythmia is an atrial tachycardia, a focal atrial fibrillation, or an orthodromic AV reentrant tachycardia involving an accessory pathway.

83. The apparatus as set forth in claim 81, further comprises a QRST subtraction means for removing a ventricular activity superimposed on an atrial activity from said electrical signals, and for outputting one or more P wave signals.

84. The apparatus as set forth in claim 81, wherein said representation is a schematic or an anatomical diagram of said left atrium.

85. The apparatus as set forth in claim 81, wherein said representation is based on using biplane fluoroscopic views of said heart.

86. The apparatus as set forth in claim 81, wherein said data maps are in the form of P wave integral maps.

87. The apparatus as set forth in claim 81, wherein said data maps are in the form of P wave potential maps.

88. The apparatus as set forth in claim 81, further comprises a verifying means for verifying said classified data maps.

89. A database of body surface ECG P wave maps for classification and localization of left atrial arrhythmias generated from P wave data of a plurality of subjects, comprising:

(a) one or more P wave data maps generated by computing, classifying and verifying said P wave data; and

(b) a reference set of map patterns specific to different left atrial ectopic origins for localizing said left atrial arrhythmias.

90. The database as set forth in claim 89, wherein said reference set of map patterns are stored in a computer-readable medium.

91. The database as set forth in claim 89, wherein one of said left atrial arrhythmias is an atrial tachycardia, a focal atrial fibrillation, or an orthodromic AV reentrant tachycardia involving an accessory pathway.